
QPC237 4-Wire E&M/DX Trunk Card

Introduction

The QPC237 4-Wire E&M/DX Trunk Card is a peripheral equipment (PE) device that can be installed in any peripheral shelf or NT8D13 Peripheral Equipment (PE) Module. The 4-wire E&M/DX trunk card interfaces two 4-wire E&M/DX trunk lines to a Meridian 1 switch. Each trunk is independently configurable using the Trunk Administration program (LD 14).

The 4-wire E&M/DX trunk provides 4-wire voice transmission with E&M or DX signaling without the necessity of going through external 2- to 4-wire conversion. Two types of E&M signaling are provided:

- Type I (as on the 2-wire E&M trunk) signaling that uses two signaling wires plus ground
- Type II signaling that uses two pairs of signaling wires and is used by most electronic switching systems

The 4-wire trunks can be equipped with software control of an external echo suppressor, which can be used when echo becomes a problem.

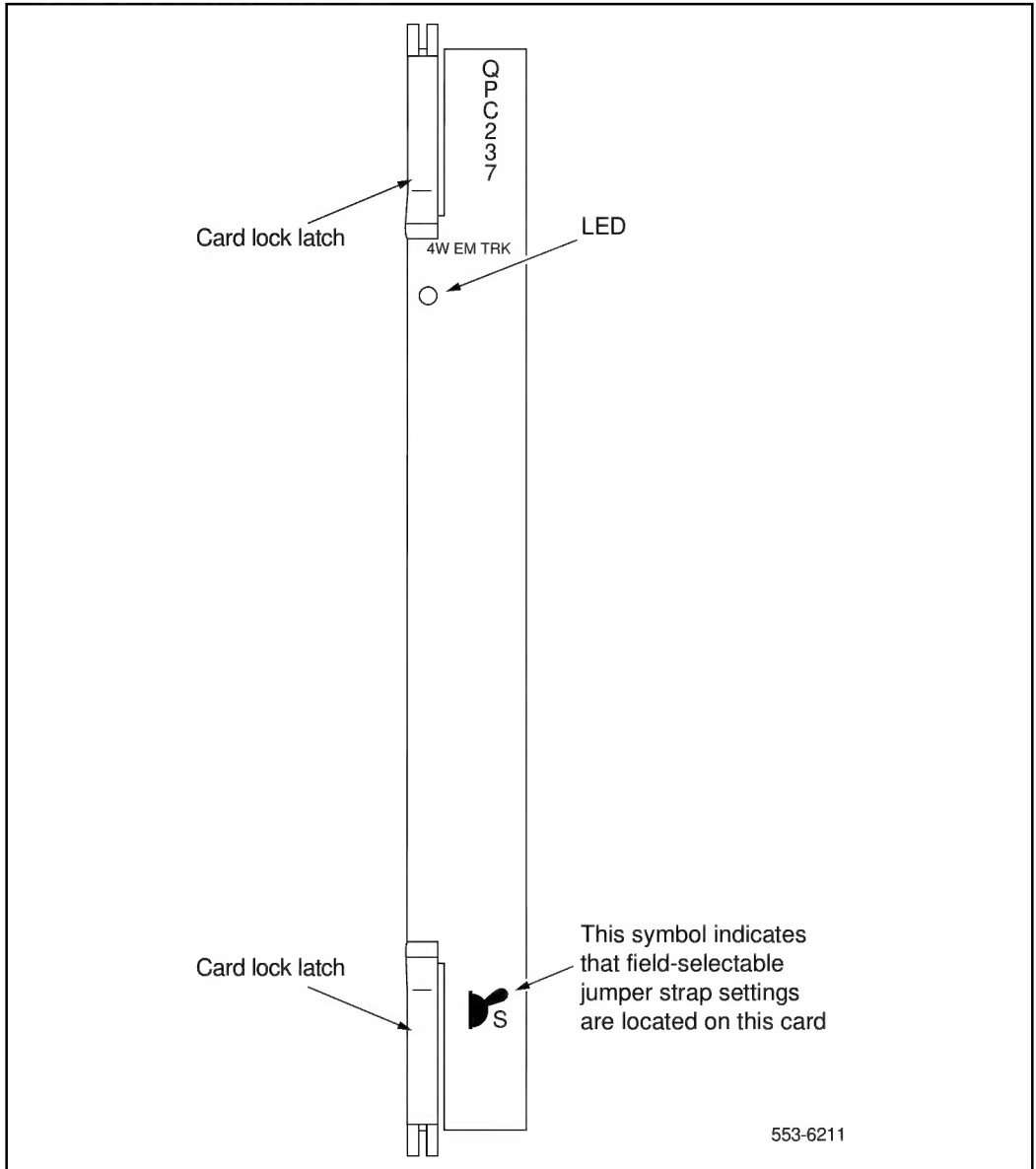
Physical description

The 4-wire E&M/DX trunk card mounts in any PE slot. The two trunk circuits and common multiplexing circuitry are mounted on a 31.74 cm by 25.4 cm (12.5 in. by 10 in.) printed circuit board.

The 4-wire E&M/DX trunk card connects to the backplane through an 80-pin connector shroud. The backplane is then cabled to the input/output (I/O) panel, which is cabled to the main distribution frame (MDF) by 25-pin cables. Trunk lines connect to the card at the MDF. See *Meridian 1 system installation procedures* (553-3001-210) for termination and cross connect information.

The faceplate of the card is equipped with a red light emitting diode (LED) (see [Figure 69](#)). The LED should only be lit if there is a problem with the card. If the LED operates in any other manner, such as continually flashing or remaining weakly lit, the card should be replaced.

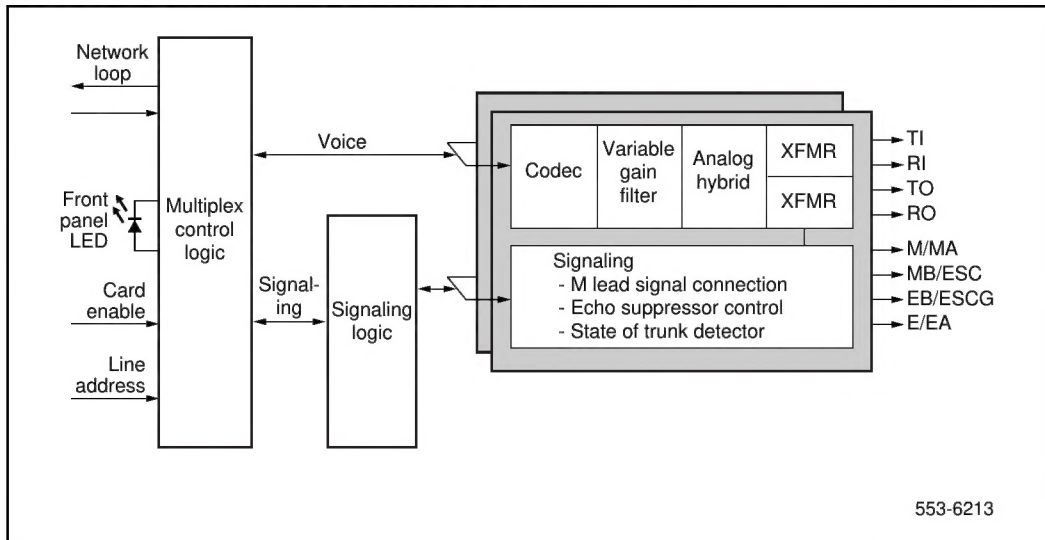
Figure 69
4-wire E&M/DX card—faceplate



Functional description

Figure 70 shows a block diagram of the major functions contained on the 4-wire E&M/DX trunk card. Each of these functions is described on the following pages.

Figure 70
4-wire E&M/DX trunk card block diagram



Card interfaces

The 4-wire E&M/DX trunk card passes both voice and signaling data over the network loop. Network loops are discussed in detail in “Peripheral equipment” on page 22.

Trunk interface units

Two 4-Wire E&M/DX signaling trunk circuits are located on each QPC237 type circuit card. Each trunk circuit can be used as a two-way, dial-repeating trunk in one of the following modes of operation to interface with appropriate types of trunk facilities.

- E&M signaling, Type I interface ([Figure 71](#))
- E&M signaling, Type II interface ([Figure 72](#))
- Back-to-back trunk circuit connection ([Figure 73](#))
- E&M signaling, Type I with M lead connections for the British Post Office (QPC237C only) ([Figure 74](#))

The 4-wire trunk circuit has the following capabilities:

- E&M/DX signaling
- Digitone sending and receiving without any modifications
- supervision of far-end off hook and dial-pulsing
- isolation of foreign potentials on the loop from portions of the transmission and signaling circuit
- controlled false detection compensation on outpulsing
- switchable 2-dB pad for controlling gain between line-to-trunk and trunk-to-trunk on normal non-VNL connections, and gain and echo protection on VNL through balance and terminal balance connections; choice of internal pad switching or control of an external echo suppressor (Type I interface only)
- switchable 7- and 16-dB pads for attenuation to accommodate carrier facilities
- 0 dB insertion loss for ESN applications (such as BARS, NARS, CDP): QPC237C/D circuit cards

The trunk circuit uses four leads to communicate voice signals: TO and RO for output and TI and RI for input. E&M signaling is accomplished using the E lead and the M lead for Type I signaling and the EA & EB and MA & MB leads for Type II signaling. DX signaling is done over the transmission lines TO–RO and TI–RI. For Type I E&M signaling, the leads ESC and ESCG are used to control the (optional) external echo suppressor.

Multiplex control

The multiplex control logic is common to both channels. This logic interfaces the individual trunk circuits to the peripheral bus signaling channel. Circuits are provided in the multiplex control logic to retime the digital signals received from the peripheral bus. Other circuits decode the address information contained on the peripheral bus to enable the individual trunk circuits during their selected time slots. Logic is also provided to enable or disable the front panel LED to indicate the service state of the card. The multiplex control logic is discussed in detail in “Peripheral equipment” on page 22.

Figure 71
Type I interface

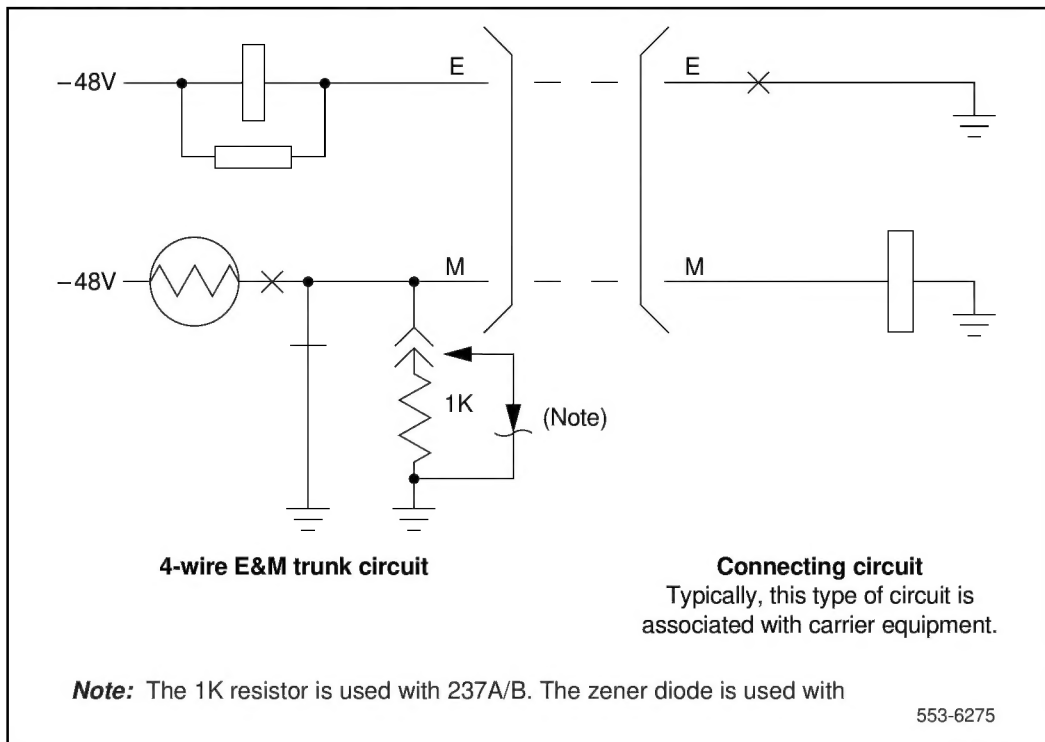


Figure 72
Type II interface

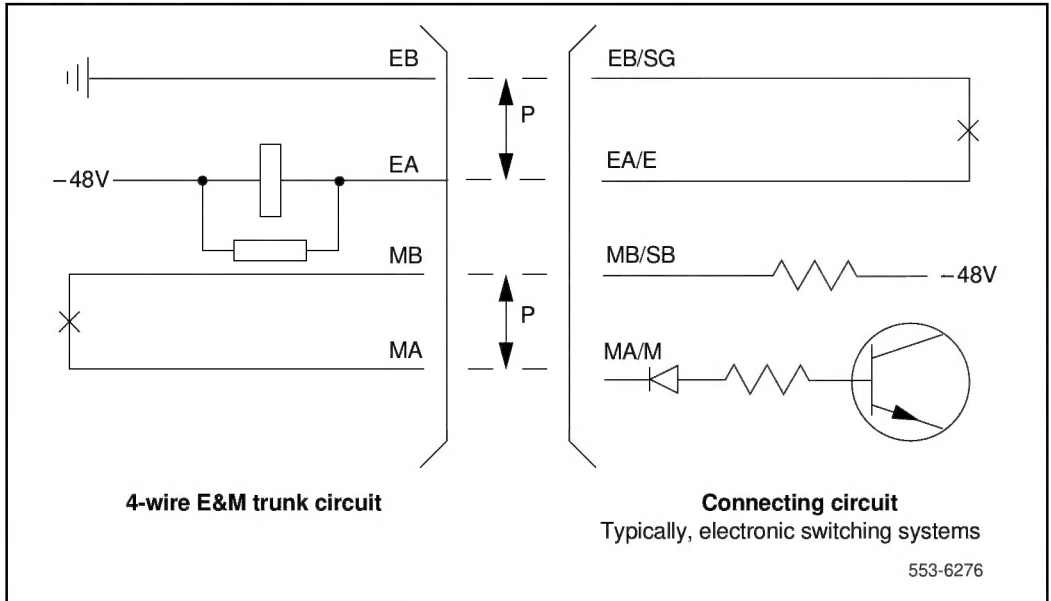


Figure 73
Back-to-back circuit connection

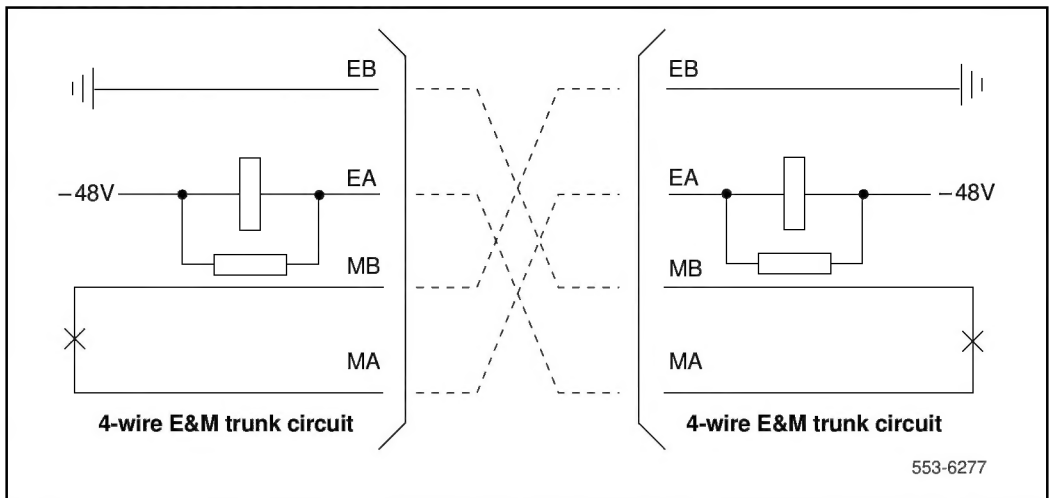
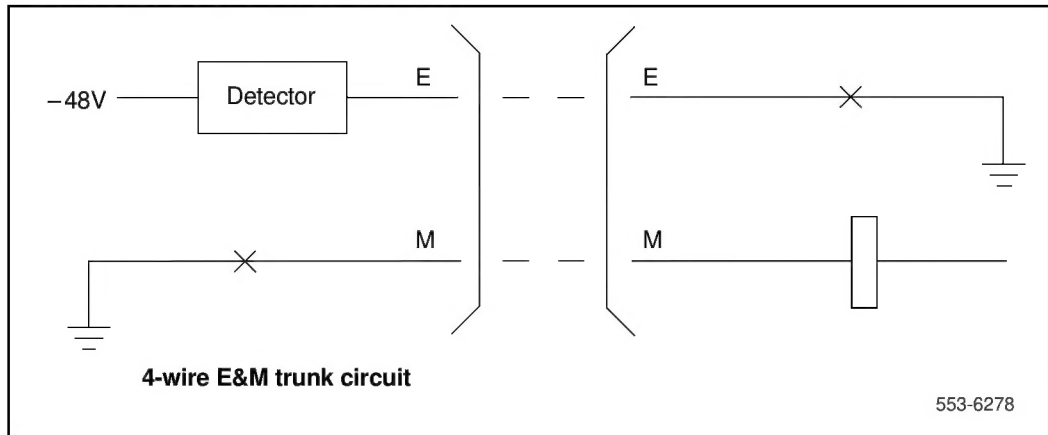


Figure 74
Type I (British Post Office) interface



Operation

E&M, Type I signaling

Release control of a call is specified in the system memory by means of the Trunk Data Block (see *X11 input/output guide*). The two options available are EITHER or ORIGINATING party control. These can be specified for the Meridian 1 system end (near end), or for the CO or other PBX end (far end). Joint party control can also be specified for the far end.

Idle circuit states

Under idle states:

- There is no current flow in the signaling lead for DX. The state of the trunk detector is high. For E&M signaling, the M lead is ground and the E lead is open circuit.
- Trunk cards are scanned periodically by the common equipment (CE). For example, the trunk circuit receives a card enable in timeslot 0. The signaling logic responds with a signal on the data input bus.

Outgoing calls

Outgoing calls are processed as follows:

- 1 The Meridian 1 machine seizes the trunk facility by sending a message to the trunk circuit signaling logic that causes relay K1 to operate. The M lead changes from ground to battery in E&M; or from no current flow to current flow in the A1 lead for DX signaling.
- 2 The signaling logic responds to the enable with a signal on the data input bus. The scan stops and the card receives further enables. The signaling logic also receives signals on the data output bus and, on receipt, outputs the contents of the input register onto the data input bus, thus reporting a change of state. The scan cycle then continues.
- 3 When ready for outpulsing, a trunk outpulsing enable is sent in an assigned timeslot (not timeslot 0 or 1), and a message is sent to the signaling logic to set up the trunk logic so that relay K1 is now controlled by the signal level of the data output bus in the assigned timeslot.
- 4 The CE, by sending the appropriate data in the selected timeslot, causes relay K1 to outpulse the required digits. (See [Tables 44, 45, and 46](#), starting on [page 192](#), for DX signaling, and [Figures 75 and 76](#), starting on [page 185](#), for E&M signaling.)

- 5 At the completion of outpulsing another message is sent to the signaling logic that restores control of K1 to the signaling logic, and the enable in the assigned timeslot is removed.
- 6 If answer supervision is provided by the far end, there is a change from open to ground on the E lead (ground detection) for E&M signaling, or from current flow to no current flow in the A1 lead (bridge unbalance detection) for DX signaling. The Scan and Signal Distributor subsequently reports a change of state to the CE.
- 7 The near end control trunk releases. See [Tables 44, 45, and 46](#) for DX signaling and [Figures 75 and 76](#) for E&M signaling.

Incoming call origination

The far end initiates calls as follows:

- 1 A ground is placed on the E lead in E&M signaling, or current flow is started in the A1 lead for DX signaling. The appropriate signaling logic input is changed from high to low. A card enable response on the data input bus stops the scan until a change of state is reported to CE.
- 2 Dial pulses are subsequently applied from the far end in the form of ground-open on the E lead, or current flow/no current flow in the A1 lead (interruptions). These are detected as changes of state at the signaling logic input.
- 3 When the call has been completed and the terminating party answers, relay K1 is operated as a result of a message from the CE to the signaling logic, causing the appropriate signal on the M leads or A1 leads.
- 4 If the far end is equipped for sending, the Meridian 1 can be operated in any mode: immediate start, delay dial, or wink start (see [Table 43](#)).
- 5 For immediate start, following the seizure signal the far end may start pulsing after the distant end controlled standard delay (normally 70 ms minimum). For wink start, following the seizure signal, within 128–256 ms the incoming trunk gives an off hook/on hook for 250 ms. On DDL a 256–384 ms off hook/on hook signal is returned to the distant end immediately.

Table 43
Start modes

Operation	Class of service
Immediate Start	IMM
Delay Dial A	IMM
Delay Dial B	DDL
Wink Start	WNK

- 6 The distant end, upon detecting this signal, may start pulsing after the distant end controlled standard delay (normally 70 ms minimum).
- 7 The trunk is released by a disconnect message to the signaling logic that causes K1 to release.

E&M, Type II signaling

Type II signaling uses four leads: EA, EB, MA, and MB. Instead of changes of state between battery and ground or open and ground, the trunk signals by making contact closures between the lead pairs MA and MB. Signals are received by detecting current flow between lead pairs EA and EB.

On outgoing calls, the Meridian 1 seizes the far end trunk by shorting the MA leads and MB leads together (instead of putting battery on the M lead as in Type I signaling). Dialing is done by opening and closing the MA/MB contact. See [Figures 77](#) and [78](#).

During incoming calls the far end seizes the trunk by shorting the EA and EB leads together. This transmits the ground from the EB lead to the EA lead (in Type I signaling the ground to the E lead comes from the far end). Dialing is done by opening and closing the EA/EB contacts. See [Figures 77](#) and [78](#).

Since the EB and MB leads also serve as the ESCG and ESC leads, respectively, echo suppressor control cannot be used with Type II signaling.

Duplex (DX) signaling

[Figures 79](#) and [80](#) show a simplified schematic diagram of a DX signaling circuit. DX signaling makes use of the voice transmission leads for signaling as well as for voice transmission. For purposes of describing the signaling, the lead pair T1/R1 is designated the signaling pair, whereas the other pair, T0/R0, conducts current in the opposite direction to balance the overall current flow between the near end and far ends.

During signaling, current flows through both T1 and R1 leads in the same direction.

Transmission

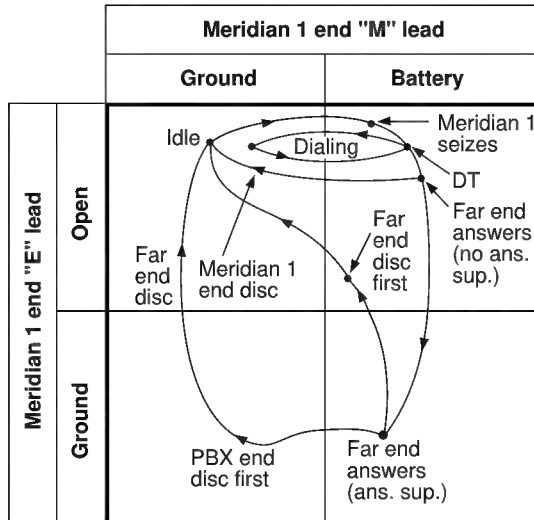
Talking connection

Audio signals received from the card tip and ring input (T1 and R1) are passed through the T1 transformer to the low-pass filter hybrid analog-to-digital filter, then through the PCM codec to the CE for switching.

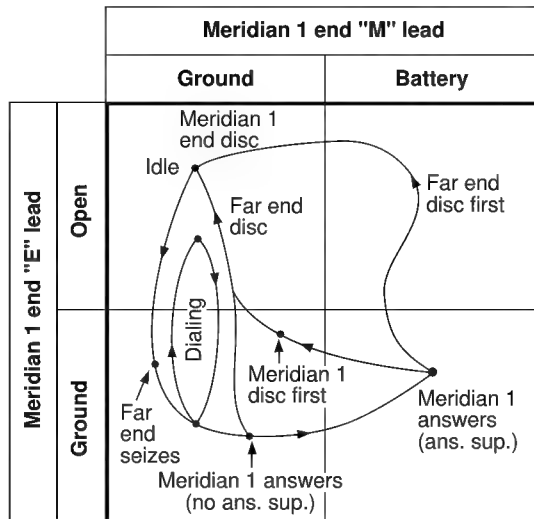
Carrier facilities

Switchable 7-dB and 16-dB pads are included in each trunk circuit to accommodate the input and output levels required for operation with carrier facilities ([Figure 80](#)). The 7-dB pad attenuates the input to the trunk (T1 and R1) and the 16-dB pad attenuates the outputs from the trunk (T0 and R0).

Figure 75
E&M lead Type I signaling patterns—originating party release
(when route does not involve a CO/FX/WATS trunk)



Outgoing calls from Meridian 1



Incoming calls from Meridian 1

553-6279

Figure 76

E&M lead Type I signaling patterns—originating party release on tandem connections when originating end is senderized and route is through a CO/FX/WATS trunk (not applicable to CCSA lines)

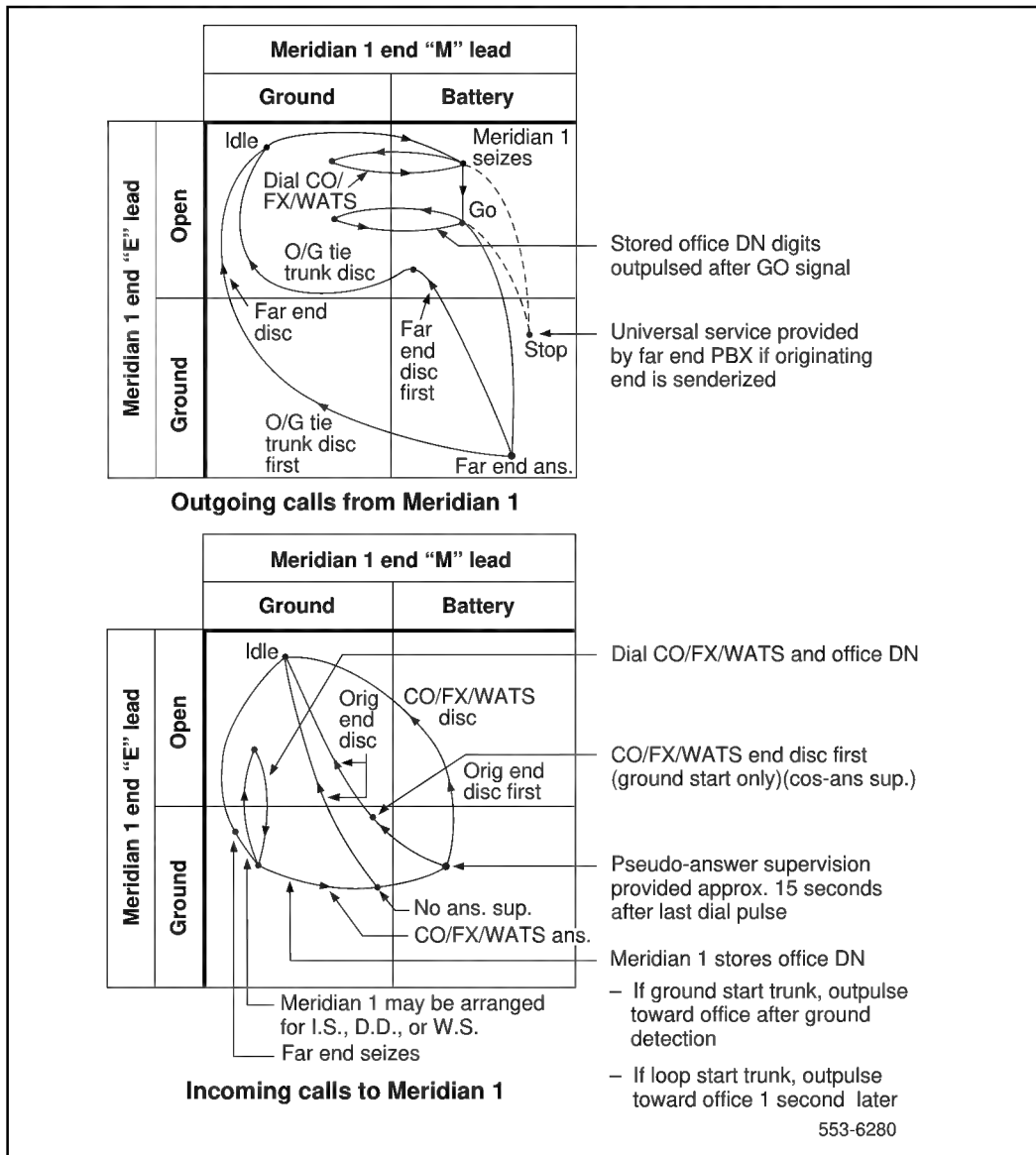
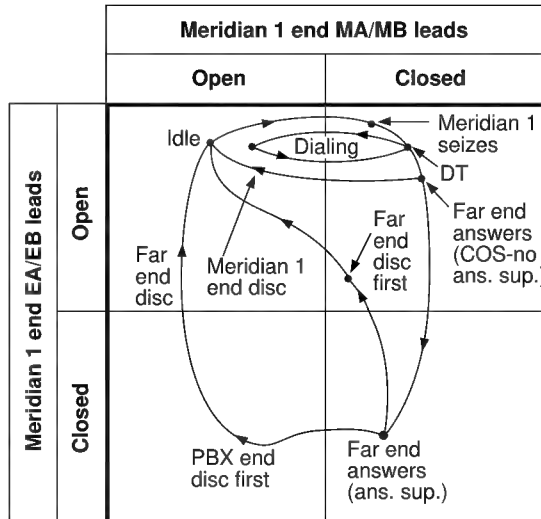
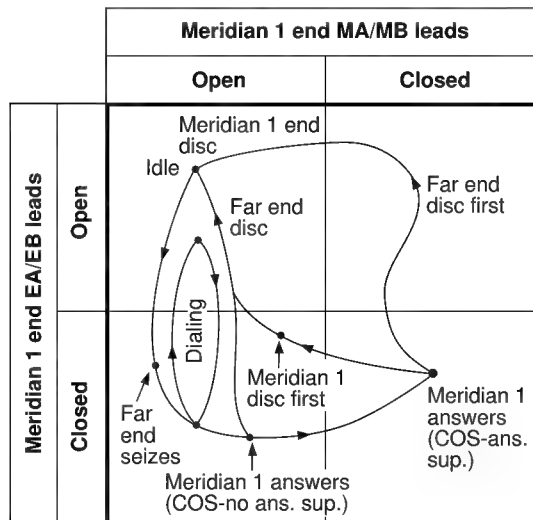


Figure 77
E&M lead Type II signaling patterns—originating party release
(when route does not involve a CO/FX/WATS trunk)



Outgoing calls from Meridian 1 (near end)



Incoming calls to Meridian 1 (near end)

553-6281

Figure 78

E&M lead Type II signaling patterns—originating party release on tandem connections when originating end is senderized and route is through a CO/FX/WATS trunk (not applicable to CCSA lines)

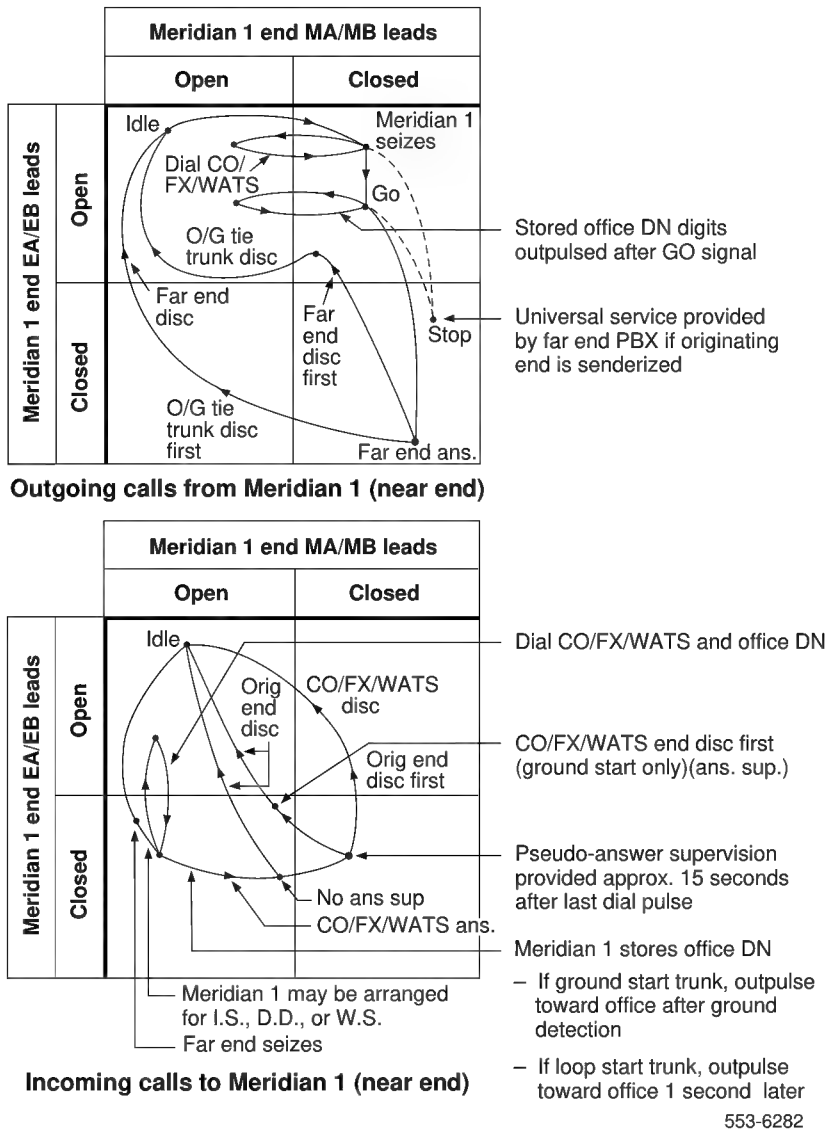


Figure 79
Simplified schematic diagram of a DX signaling (4-wire) circuit for the QPC237A/B

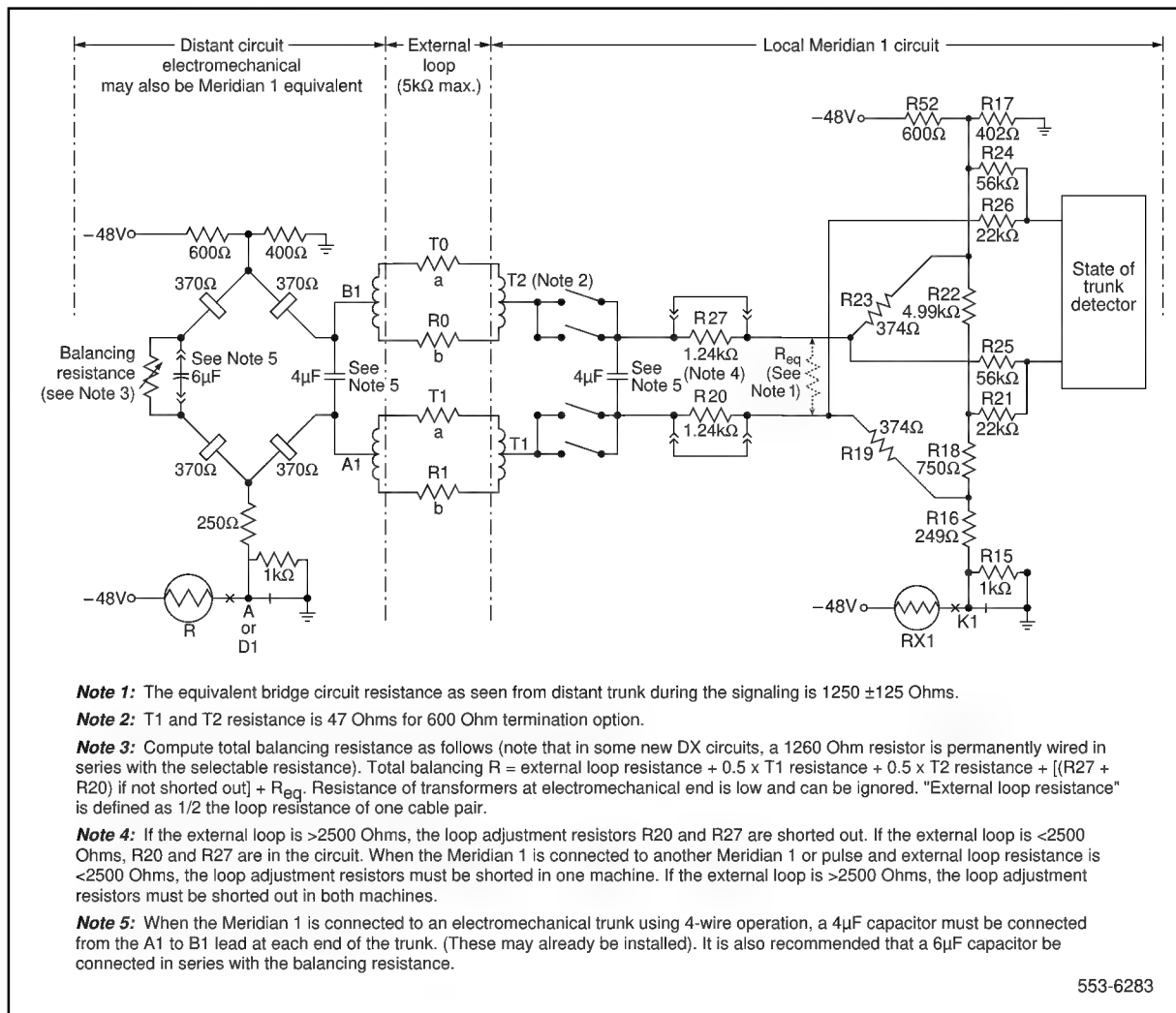
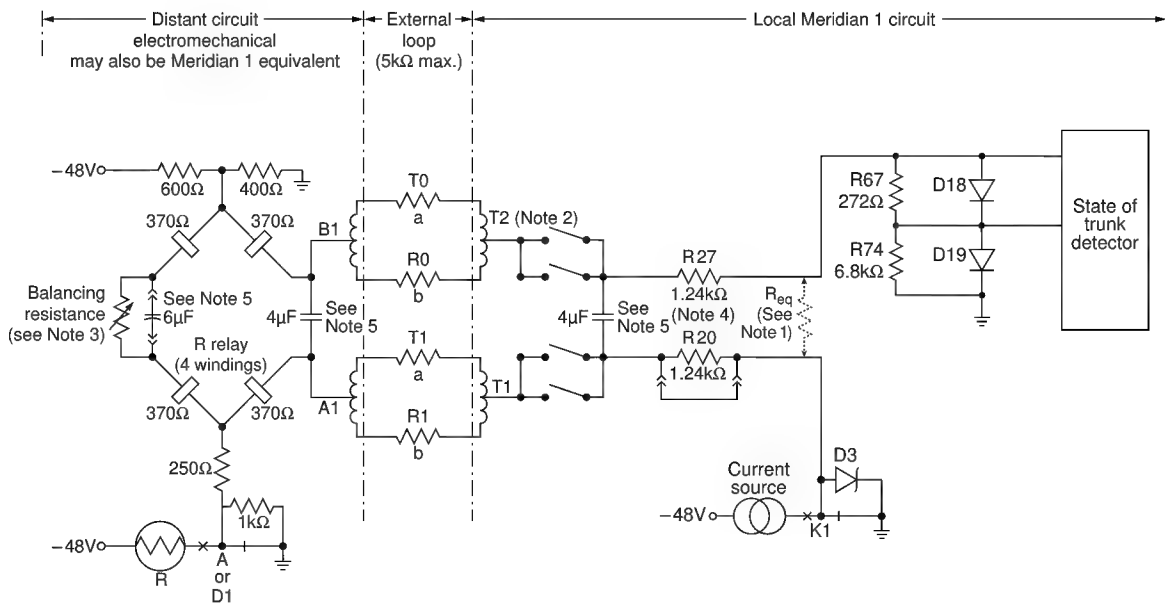


Figure 80
Simplified schematic diagram of a DX signaling (4-wire) circuit for the QPC237C



Note 1: The equivalent bridge circuit resistance as seen from distant trunk during the signaling is 7072 ± 707 Ohms.

Note 2: T1 and T2 resistance is 47 Ohms for 600 Ohm termination option.

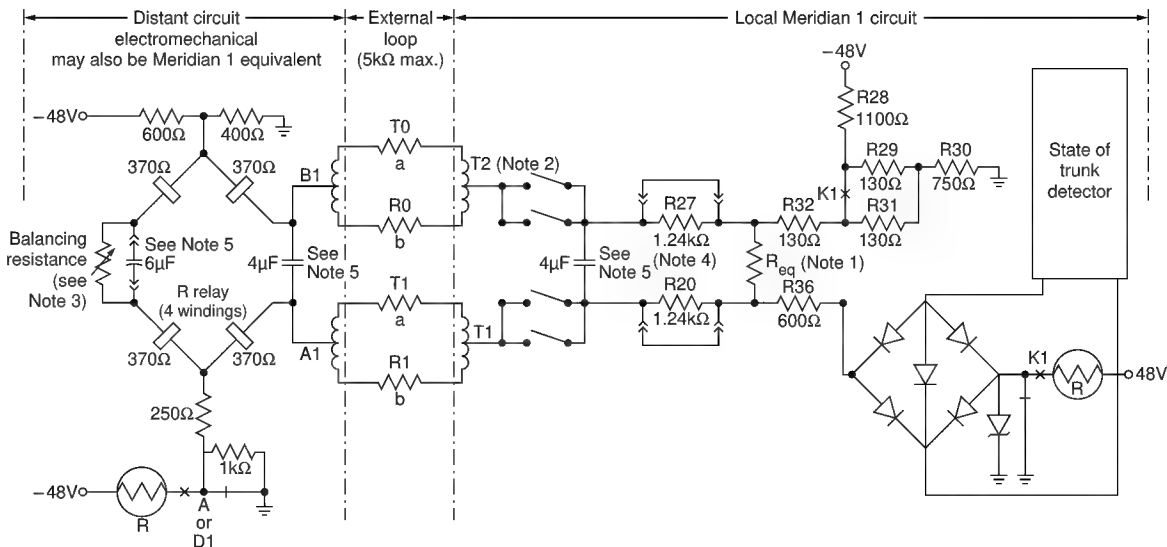
Note 3: Compute total balancing resistance as follows (note that in some new DX circuits, a 1260 Ohm resistor is permanently wired in series with the selectable resistance). Total balancing $R = \text{external loop resistance} + 0.5 \times T1 \text{ resistance} + 0.5 \times T2 \text{ resistance} + [(R27 + R20) \text{ if not shorted out}] + R_{eq}$. Resistance of transformers at electromechanical end is low and can be ignored. "External loop resistance" is defined as 1/2 the loop resistance of one cable pair.

Note 4: If the external loop is >2500 Ohms, the loop adjustment resistors R20 and R27 are shorted out. If the external loop is <2500 Ohms, R20 and R27 are in the circuit. When the Meridian 1 is connected to another Meridian 1 or pulse and external loop resistance is <2500 Ohms, the loop adjustment resistors must be shorted in one machine. If the external loop is >2500 Ohms, the loop adjustment resistors must be shorted out in both machines.

Note 5: When the Meridian 1 is connected to an electromechanical trunk using 4-wire operation, a 4μF capacitor must be connected from the A1 to B1 lead at each end of the trunk. (These may already be installed). It is also recommended that a 6μF capacitor be connected in series with the balancing resistance.

553-6284

Figure 81
Simplified schematic diagram of a DX signaling (4-wire) circuit for the QPC237D



Note 1: The equivalent bridge circuit resistance as seen from distant trunk during the signaling is 1250 ± 125 Ohms.

Note 2: T1 and T2 resistance is 47 Ohms for 600 Ohm termination option.

Note 3: Compute total balancing resistance as follows (note that in some new DX circuits, a 1260 Ohm resistor is permanently wired in series with the selectable resistance). Total balancing $R = \text{external loop resistance} + 0.5 \times T1 \text{ resistance} + 0.5 \times T2 \text{ resistance} + [(R_A + R_D) \text{ if not shorted out}] + R_{eq}$. Resistance of transformers at electromechanical end is low and can be ignored. "External loop resistance" is defined as 1/2 the loop resistance of one cable pair.

Note 4: If the external loop is >2500 Ohms, the loop adjustment resistors R20 and R27 are shorted out. If the external loop is <2500 Ohms, R20 and R27 are in the circuit. When the Meridian 1 is connected to another Meridian 1 or pulse and external loop resistance is <2500 Ohms, the loop adjustment resistors must be shorted in one machine. If the external loop is >2500 Ohms, the loop adjustment resistors must be shorted out in both machines.

Note 5: When the Meridian 1 is connected to an electromechanical trunk using 4-wire operation, a $4\mu\text{F}$ capacitor must be connected from the A1 to B1 lead at each end of the trunk. (These may already be installed.) It is also recommended that a $6\mu\text{F}$ capacitor be connected in series with the balancing resistance.

553-6285

Table 44
DX signaling—originating party release

Condition	Current in signaling lead	State of trunk detector
OUTGOING CALLS		
Idle	no current flow	high
Seizure (dial tone from far end: far end ready for digits)	current flow	high
Digits	current flow interrupted for each pulse	high
Far end answers	no current flow	low
Far end on hook first	current flow	high
Network taken down and trunk idled when near end goes on hook	no current flow	high
Near end on hook first, network taken down	current flow	low
Far end on hook trunk idled	no current flow	high
INCOMING CALLS		
Idle	no current flow	high
Seizure (dial tone to far end: near end ready for digits)	current flow	low
Digits	current flow interrupted for each pulse	low-high-low for each pulse
Near end answers	no current flow	low
Far end on hook first	current flow	high
Network taken down and trunk idled	no current flow	high
Near end on hook first, network taken down	current flow	low
Far end on hook trunk idled	no current flow	high

Table 45**DX signaling—originating party release on tandem connections for outgoing calls**

Condition	Current in signaling lead	State of trunk detector input to signaling logic
Idle	no current flow	high
Seizure (far end ready for digits)	current flow	high
Dial CO/FX/WATS	current flow interrupted for each pulse	high
Stop sender	no current flow	low
Go sender (universal service provided by far end PBX if originating end is senderized)	current flow	high
CO/FX/WATS offices ready for digits		
Stored Office DN digits	current flow interrupted for each pulse	high
Outpulsed	no current flow	low
Far end answers	no current flow	low
Far end on hook first	current flow	high
Near end on hook, network taken down, trunk idled	no current flow	high
Near end on hook first, network taken down	current flow	low
Far end on hook idled	no current flow	high

Table 46
DX signaling—originating party release on tandem connections for incoming calls

Condition	Current in signaling lead	State of trunk detector input to signaling logic
Idle	no current flow	high
Seizure (Meridian 1 may be arranged for IS, DD, or WS)	current flow	low
(near end ready for digits)	current flow	low
Dial CO/FX/WATS and office DN	current flow interrupted for each pulse	low-high-low for each pulse
Stored digits outpulsed on CO/FX/WATS trunk after ground detection if ground start, but after 3 seconds if loop start		
If ANS SUP, pseudo-answer supervision is sent approximately 13 seconds after last dial pulse received	no current flow	low
If NO ANS SUP	current flow	low
CO end disconnects (CO ground start—trunk idled and network taken down, but incoming tie trunk held under control of originating end)	current flow	low
Originating end disconnects—network taken down and trunk idled	no current flow	high

Electrical specifications

This section lists the electrical specifications for the 4-wire E&M/DX trunk card.

Trunk interface electrical characteristics

[Table 47](#) shows the electrical characteristics of the 4-wire E&M/DX trunk interface units.

Table 47
Electrical characteristics

Characteristics	Comment
Circuits per card	2
Options	
(1) Signaling	DX or E&M Type I or II
(2) DX loop resistance	Switchable, 0 to 2500 Ω or 2500 to 5000 Ω
DX signaling	
External circuit resistance allowed	5 k Ω maximum
Insulation resistance required	100 k Ω minimum
Ground potential difference allowed	± 10 V maximum
E&M signaling	
Feed resistance	M lead, 100 Ω minimum
Contact bounce	M lead, 3 ms maximum
Operating range	Type I 100–150 Ω
	Type II 100–300 Ω
Dial pulse operation	Sending: 10 pps, 58 to 64% break
	Receiving: 10 pps, recognize 10–150 ms as break/make
Terminating impedance	600 Ω

Power requirements

[Table 48](#) shows the typical current that the 4-wire E&M/DX trunk card requires from each power supply.

Table 48
Power requirements

Voltage	Tolerance	Current (typical)
+10 V dc	± 5%	30 mA
−10 V dc	± 5%	30 mA
+6 V	± 1%	8 mA
−6 V	± 1%	8 mA
−48 V dc	± 12%	100 mA

Foreign and surge voltage protections

When telephone lines connected to the trunk circuit are exposed to foreign voltages by direct contact or induction (e.g., power line crosses or lightning), protection devices must be installed on the customer's premises. These devices must be capable of providing a path to ground from tip and ring for foreign voltages that exceed 600 V peak.

Environmental specifications

[Table 49](#) lists the environmental specifications for the 4-Wire E&M/DX trunk card.

Table 49
Environmental specifications

Parameter	Specifications
Operating temperature	0° to +60° C (+32 to +140° F), ambient
Operating humidity	5 to 95% RH (noncondensing)
Storage temperature	−40° to +70° C (−40° to +158° F)

Connector pin assignments

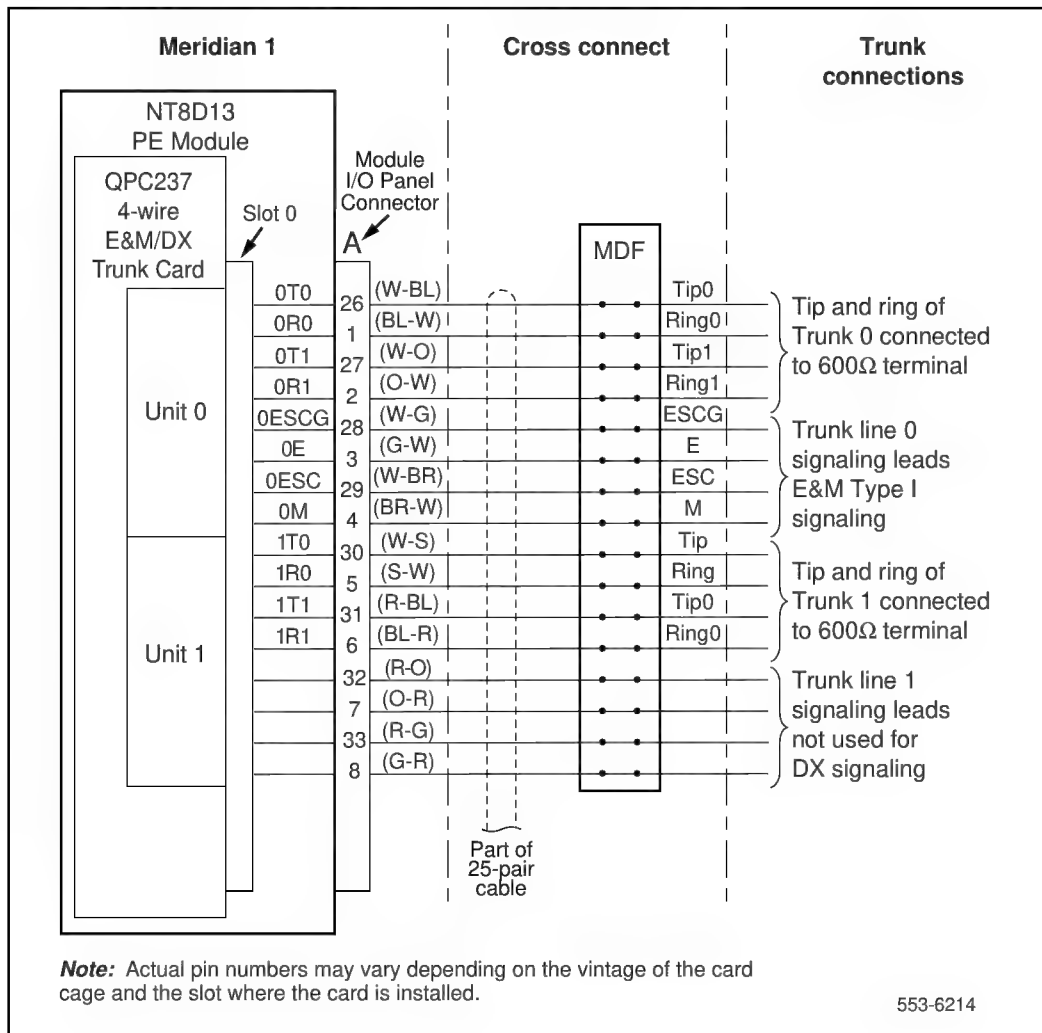
The 4-wire E&M/DX trunk card brings the analog trunks to the PE backplane through an 80-pin connector shroud. The backplane is cabled to the input/output (I/O) panel on the rear of the module, which is then connected to the main distribution frame (MDF) by 25-pair cables.

The 4-wire E&M/DX trunks connect to the trunk card at the MDF using a wiring plan similar to that used for line cards. A typical connection example is shown in [Figure 82](#), and a list of the connections to the 4-wire E&M/DX trunk card is shown in [Table 50](#). See *Meridian 1 system installation procedures* (553-3001-210) for complete I/O panel connector information and wire assignments for each tip/ring pair.

Table 50
4-wire E&M/DX trunk card—connections

Connector Pin	Lead Designation			Unit
	E&M Type I	E&M Type II	DX	
36A	Tip 0	Tip 0	Tip 0	0
37A	Ring 0	Ring 0	Ring 0	
38A	Tip 1	Tip 1	Tip 1	
39A	Ring 1	Ring 1	Ring 1	
29A	ESCG	EB	N/A	
30A	E	EA	N/A	
31A	ESC	MB	N/A	
32A	M	MA	N/A	
2A	Tip 0	Tip 0	Tip 0	1
3A	Ring 0	Ring 0	Ring 0	
4A	Tip 1	Tip 1	Tip 1	
5A	Ring 1	Ring 1	Ring 1	
9A	ESCG	EB	N/A	
10A	E	EA	N/A	
11A	ESC	MB	N/A	
12A	M	MA	N/A	

Figure 82
4-wire E&M/DX trunk card—typical cross connection example



Configuration

The optional application, features, and signaling arrangement for each trunk are assigned through unique trunk data blocks contained in the system memory. Trunk options for the QPC237D are selected manually by setting option pads. The locations of these switches are shown in [Figure 83](#).

Switch settings

Trunk options for the QPC237A/B are selected manually by setting six option pads. There are three pads per circuit and each pad contains either four or six switches. See *Circuit card installation and testing* (553-3001-211).

Trunk options for the QPC237C are selected manually by setting eight option pads. There are four pads per circuit and each pad contains either four or six switches. See *Circuit card installation and testing* (553-3001-211).

Trunk options for the QPC237D are selected manually by setting option pads. There are three pads per circuit and each pad contains either 6 or 10 switches. The switch settings are shown in [Tables 51](#) and [52](#).

Service change entries

The optional application, features, and signaling arrangement for each trunk are assigned through unique trunk data blocks contained in the system memory. The type of assignments in question are tie, CCSA, E&M, DX, start arrangement, transmission, and compensation.

Figure 83
4-wire E&M trunk card—switch locations

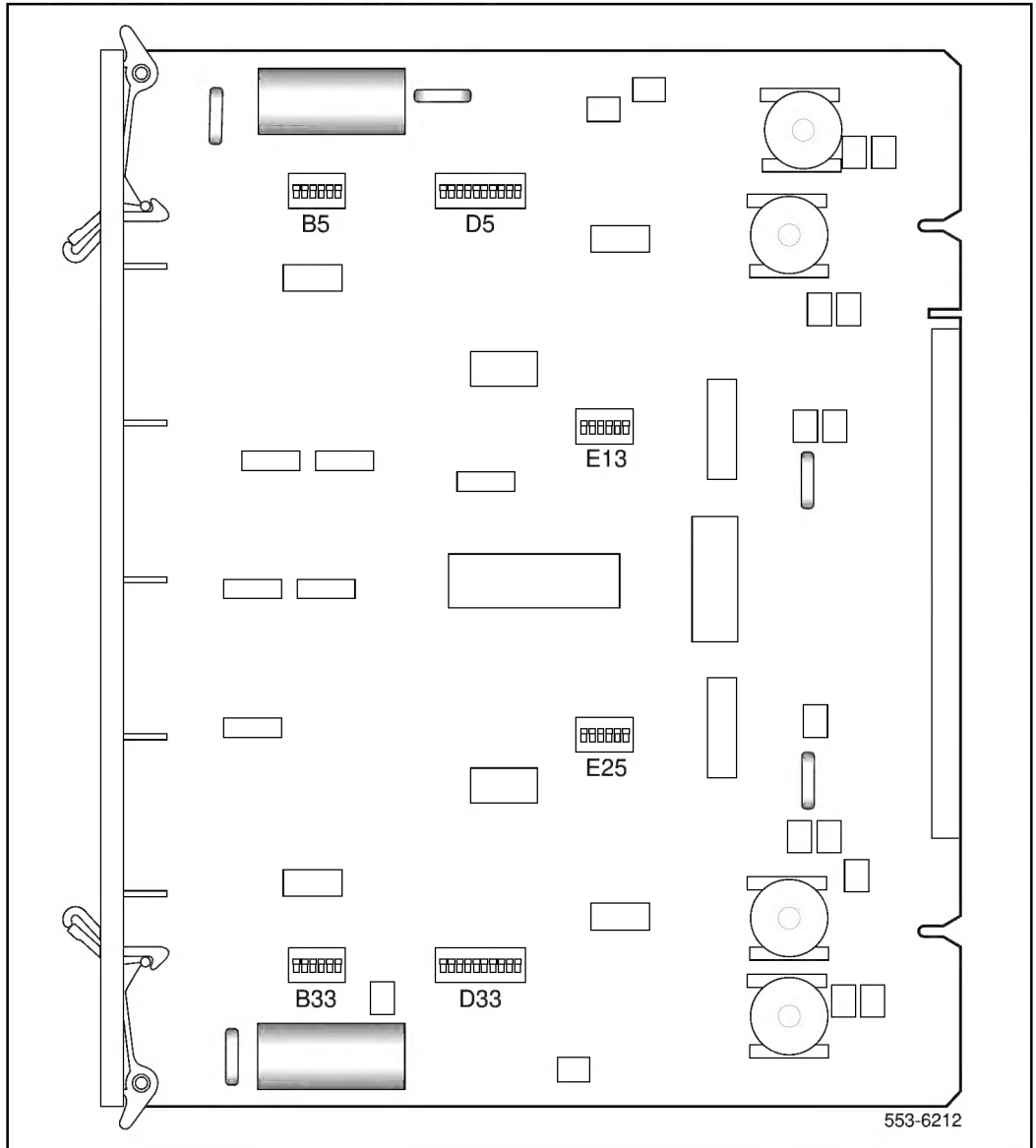


Table 51
4-wire E&M trunk card—S1 and S2 switch settings

Application	Unit 0: Unit 1:		S1 (D33) S2 (D5)							
	1	2	3	4	5	6	7	8	9	10
E&M Type I	off	off	off	off	off	off	off	off	on	off
E&M Type II	off	off	off	off	off	off	off	off	on	off
British Telecom	off	off	off	off	off	off	off	off	on	off
DX 4-Wire lead M to T1, E to E2	off	on	off	on			on	on	off	on
DX 4-Wire lead M to T2, E to E1	on	off	on	off			on	on	off	on
Conductor loop > 2.5 K Ω					on	on				
Conductor loop < 2.5 K Ω					off	off				

Table 52**4-wire E&M trunk card—S3, S4, S5, and S6 switch settings**

Unit 0: Unit 1: Application	S3 (E25) S5 (E13)						S4 (B33) S6 (B5)					
	1	2	3	4	5	6	1	2	3	4	5	6
E&M Type I		on		on	on	on	off	off	on	on	off	off
E&M Type II		on		on	on	off	off	on	off	off	on	off
British Telecom		on		on	on	off	on	off	off	off	off	off
DX 4-Wire lead, M to T1, E to E2		on		on	off	on	off	off	on	on	off	off
DX 4-Wire lead, M to T2, E to E1		on		on	off	on	off	off	on	on	off	off
Interface												
— Carrier network	on			on								
— Public network		off			off							